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FISKERIDIREKTORATETS SKRIFTER
Serie Havundersøkelser
*(Report on Norwegian Fishery and Marine Investigations Vol. IV, No. 4)*

Published by the Director of Fisheries

# On the Age and Growth of the Pollack (*Gadus pollachius* L.) from the Norwegian Skagerrack Coast

By

ALF DANNEVIG
and ADOLF SØRENSEN

The Flødevig Sea-Fish Hatchery
September 1932

1 9 3 3

A.s John Griegs Boktrykkeri, Bergen

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Earlier examinations of the scales of the cod from the waters near the Norwegian Skagerrack coast revealed that the ordinary scale theory did not hold good for this species. The narrow parts of the scales were formed, as a rule, during late Summer, not during Winter. (Alf Dannevig: "On the Growth of the Cod and the Formation of Annual Zones in the Scales. Experiments at the Flødevig Sea-Fish Hatchery", Bergen 1925. And Alf Dannevig: "On the Age and Growth of the Cod from the Norwegian Skagerrack Coast", Bergen 1933.

From these investigations it is obvious that the first zone is formed in the calendar year of hatching — according to the old theory it is formed in the following Winter. We have thus a constant difference in age of one year between the results of the two methods for the cod collected during Autumn & Winter. A cod caught in November showing one distinct zone belongs to the brood of the same year.

In addition we had some uncertainty in reading the cod scales. It proved that in some fish an additional zone was formed during Winter — and it was impossible to distinguish between the two zones. (In the cod, however, the otoliths were much easier to decipher).

In the case of young salmon it was also found that the first zone was formed in late Summer. (Alf Dannevig: "Om dannelsen av årringer i lakseungenes skjell", Oslo 1928) *).

When dealing with the pollack from our waters it was found necessary to examine the scales on this point.

The pollack scale has well defined zones (Fig. I), and secondary zones, which are of a character apt to give rise to uncertainty, seldom occur. In the scales of most pollack, however, a faint zone is found near the centre — probably of the same character as the Summer zone in the cod scale, but far less prominent. Fig. 2.

By examining the scales it was found that the zone with narrow sclerites was ordinarily found near the margin of the scale, if the fish

*) Arwidson (1910) was of the opinion that the first zone was formed when the young salmon had attained a definite size — and that this size was often reached in late Summer. Hence the occurrence of "Winter-zones" in that season.

was caught during Spring. In order to have this point verified some of our material (i.e. scales from 2145 pollack caught in traps in the years 1922 — 1930 incl.), was examined to this end.

Fig. 1. Scale of Pollack 41 cm. $^{26}/_{4}$. 1928 Søndeledfjord. Showing two distinct zones, the third at the margin.

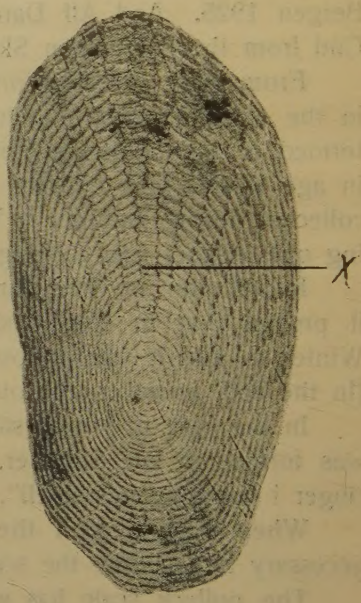


Fig. 2. Scale of Pollack 19 cm. $^{6}/_{1}$. 1926 Søndeledfjord. Showing the Summer check (×).

The material was collected from the following localities:

| | | |
|---|---|---|
| Bærøfjord (Kragerø) | 109 | specimens |
| Kjøbmandsfjord „ | 77 | „ |
| Søndeledfjord (Risør) | 962 | „ |
| Flødevigen (Arendal) | 298 | „ |
| Topdalsfjord (Kristiansand) | 699 | „ |

In tab. I a & I b the material is grouped for each month according to the number of zones found in the scales. It is evident that the new zones occur in May—June for the young fish, and in June—July for the older. The zones of narrow sclerites must, therefore, have been formed during the previous months — apparently during the biological Winter.

As will be understood this stands in direct contrast to the results previously arrived at for the cod from the same waters, and is more in conformity with the general scale theory. The new growth, however, occurs much later in the season. The difference between the two species may be ascribed to the difference in the normal occurrence of the two species. In our waters the cod is to be regarded as a northerly form — the pollack, however, as a southerly form.

By the examination of the material it was also noted that the relatively fast growing fish seemed to form the zones at an earlier date than the slow growers. It also appeared that the zone was formed at an earlier date in years with high sea-temperatures than with low ones.

The material is, however, too scanty to enable us to give definite figures.

The distance between the "centre" of the scales and the margin of the different zones was measured, and on the assumption that the growth of the scale and the growth of the fish were proportional, the length increment of the fish $t_0$, $t_1$, $t_2$ etc. was reckoned for each season of growth.

The measurement of the margin of the scale expressed as the corresponding growth of the fish in centimetres is compiled in tab. 2. For the older fish the material is scanty, (see tab. 1 b.) and as the time of the formation of the zone is not so strictly defined as in the case of the younger fish, we wish especially to draw attention to the younger classes.

The table shows that the margin was smallest in May—June, and augmented till July of the next year. In the months of May—July some fish were found with narrow sclerities near the margin — in others the new growth had begung. The two modifications are tabulated in the lower and the upper part of the table respectively.

In fig. 3 the width of the margin is given graphically for each month during one year. On account of the material being scanty the older fish are excluded, and the few specimens forming their zones very early or very late are also omitted.

It is evident that the margin of the scale is relatively great in the youngest fish — and that the chief increment occurs during Summer.

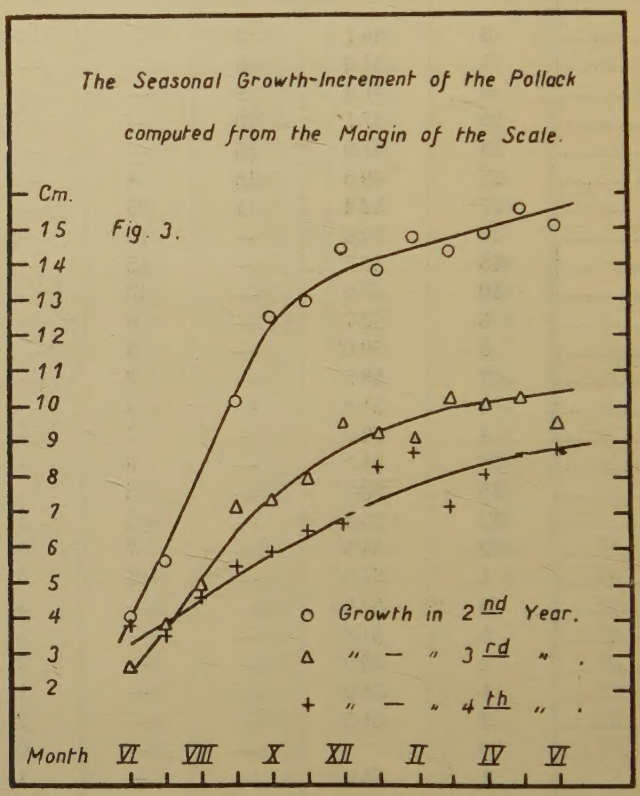
Tab. 1 a. *Pollack grouped according to number of zones.*

| | No. examined | Average length | No. of Zones: | | | |
|---|---|---|---|---|---|---|
| | | | 0 | 1 | 2 | 3 |
| December | 2 | 19·5 | 2 | — | — | — |
| January | 5 | 20·4 | 5 | — | — | — |
| February | 5 | 20·0 | 5 | — | — | — |
| March | 2 | 21·0 | 2 | — | — | — |
| April | 3 | 21·3 | 3 | — | — | — |
| May | 1 | 22·0 | — | 1 | — | — |
| June | 9 | 22·9 | — | 9 | — | — |
| July | 75 | 23·5 | — | 75 | — | — |
| August | 206 | 25·2 | — | 206 | — | — |
| September | 163 | 26·2 | — | 163 | — | — |
| October | 162 | 28·0 | — | 162 | — | — |
| November | 217 | 28·4 | — | 217 | — | — |
| December | 136 | 29·5 | — | 136 | — | — |
| January | 47 | 30·9 | — | 47 | — | — |
| February | 34 | 30·2 | — | 34 | — | — |
| March | 44 | 31·6 | — | 44 | — | — |
| April | 69 | 31·0 | — | 69 | — | — |
| May | 39 | 32·3 | — | 39 | — | — |
| June | 45 | 32·6 | — | 24 | 21 | — |
| July | 70 | 33·1 | — | 1 | 69 | — |
| August | 88 | 34·9 | — | — | 88 | — |
| September | 58 | 37·0 | — | — | 58 | — |
| October | 34 | 36·3 | — | — | 34 | — |
| November | 57 | 35·2 | — | — | 57 | — |
| December | 28 | 37·5 | — | — | 28 | — |
| January | 16 | 38·3 | — | — | 16 | — |
| February | 7 | 41·1 | — | — | 7 | — |
| March | 12 | 39·3 | — | — | 12 | — |
| April | 29 | 40·8 | — | — | 29 | — |
| May | 33 | 40·6 | — | — | 33 | — |
| June | 28 | 41·4 | — | — | 17 | 11 |
| July | 15 | 42·7 | — | — | 2 | 13 |
| August | 36 | 44·8 | — | — | 2 | 34 |
| September | 30 | 46·2 | — | — | — | 30 |
| October | 23 | 47·4 | — | — | — | 23 |
| November | 19 | 47·0 | — | — | — | 19 |
| December | 9 | 45·0 | — | — | — | 9 |

Tab. 1 b. *Pollack grouped according to number of zones.*

| | No examined | Average length | No. of zones: | | | |
|---|---|---|---|---|---|---|
| | | | 3 | 4 | 5 | 6 |
| January | 3 | 48·7 | 3 | — | — | — |
| February | 5 | 47·6 | 5 | — | — | — |
| March | 9 | 47·8 | 9 | — | — | — |
| April | 20 | 47·7 | 20 | — | — | — |
| May | 35 | 47·9 | 35 | — | — | — |
| June | 22 | 49·5 | 18 | 4 | — | — |
| July | 27 | 52·4 | 1 | 26 | — | — |
| August | 13 | 52·6 | — | 13 | — | — |
| September | 15 | 53·7 | — | 15 | — | — |
| October | 10 | 53·0 | — | 10 | — | — |
| November | 6 | 52·7 | — | 6 | — | — |
| December | 8 | 50·6 | — | 8 | — | — |
| January | 2 | 58·5 | — | 2 | — | — |
| February | 4 | 51·8 | — | 4 | — | — |
| March | 4 | 52·0 | — | 4 | — | — |
| April | 8 | 51·1 | — | 8 | — | — |
| May | 15 | 53·2 | — | 15 | — | — |
| June | 12 | 55·8 | — | 9 | 3 | — |
| July | 2 | 54·5 | — | 2 | 0 | — |
| August | 1 | 57·0 | — | 1 | 0 | — |
| September | 5 | 57·0 | — | — | 5 | — |
| October | 5 | 54·8 | — | — | 5 | — |
| November | 2 | 59·0 | — | — | 2 | — |
| December | 1 | 55·0 | — | — | 1 | — |
| January | 2 | 61·5 | — | — | 2 | — |
| February | 0 | | — | — | 0 | — |
| March | 1 | 55·0 | — | — | 1 | — |
| April | 4 | 56·8 | — | — | 4 | — |
| May | 3 | 56·0 | — | — | 3 | — |
| June | 6 | 60·3 | — | — | 6 | — |
| July | 5 | 59·6 | — | — | 5 | — |
| August | 7 | 60·6 | — | — | 6 | 1 |
| September | 8 | 61·5 | — | — | 7 | 1 |
| October | 1 | 59·0 | — | — | — | 1 |
| November | 1 | 51·0 | — | — | — | 1 |
| December | 1 | 67·0 | — | — | — | 1 |

In table 3 the computed length of the fish is given for the 1924 year-group. The values are given for each age (number of zones) separately. It will be seen that the $1_1$ diminishes as we pass from the young to the older fish. This means that the method of calculating 1 cannot be very accurate. Here we have to do with the phenomenon of Miss Lee (1912) found by her in both herring and haddock.




In table 4 the total result for all year-groups from the Søndeledfjord is given. The results arrived at from the single year-groups are confirmed, the $1_1$ diminishing when more zones are formed.

There remains the fact that the calculated length of the fish of the same year-group at the time of the finishing of the zones diminishes when the fish grows older; we are not, however, in a position to discuss the cause of this phenomenon on the basis of the material at hand. We will only draw attention to the fact that it will not be safe to study the growth of the pollack from year to year by ordinary scale measurements. It is possible, however, that a correction may be found which will eliminate the discrepancies in the measurements.

Tab. 2. *Width of the margin of the scale after zone No.:*

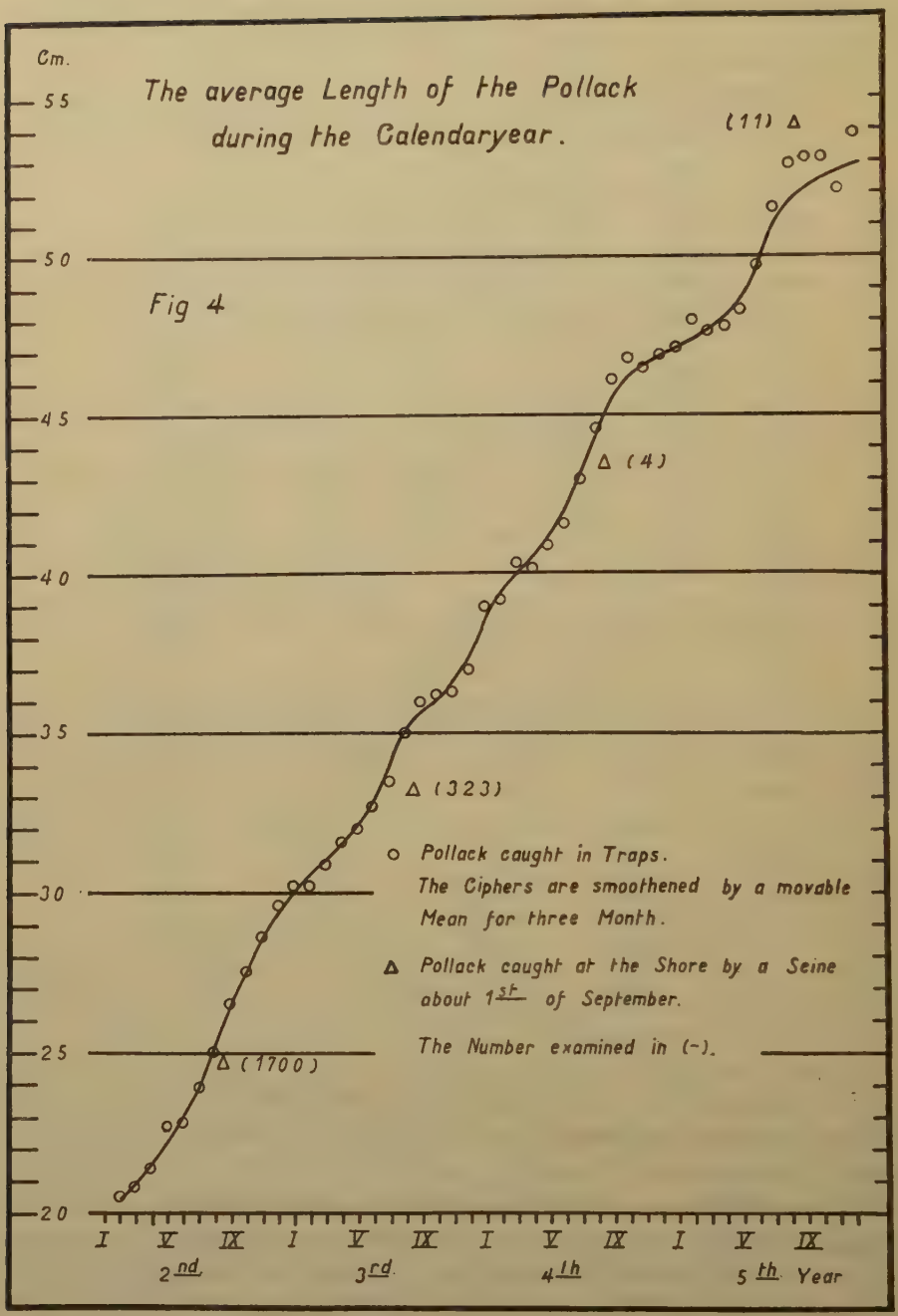
| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| V | 2·0 | — | — | — | — | — | — | — |
| VI | 4.1 | 2·6 | 3·8 | 4·5 | 2·3 | — | — | — |
| VII | 5·7 | 3·8 | 3·5 | 5·7 | — | — | — | — |
| VIII | 8·5 | 4·9 | 4·6 | 4·8 | — | 3·0 | — | — |
| IX | 10·2 | 7·1 | 5·5 | 7·7 | 3·9 | 3·0 | — | 3·0 |
| X | 12·6 | 7·3 | 5·9 | 4·2 | 4·2 | 5·0 | — | — |
| XI | 13·0 | 7·9 | 6·5 | 4·7 | 3·7 | 3·0 | 4·0 | — |
| XII | 14·5 | 9·5 | 6·7 | 5·7 | 7·0 | 5·0 | — | — |
| I | 13·9 | 9·2 | 8·3 | 6·0 | 6·5 | — | — | — |
| II | 14·8 | 9·0 | 8·7 | 5·3 | — | — | — | — |
| III | 14·4 | 10·2 | 7·2 | 4·7 | 7·0 | 4·0 | — | — |
| IV | 14·9 | 10·0 | 8·1 | 5·5 | 5·7 | 4·0 | — | — |
| V | 15·6 | 10·2 | 8·7 | 6·1 | 6·5 | 5·0 | — | — |
| VI | 15·1 | 9·5 | 8·8 | 7·2 | 5·9 | — | 5·0 | — |
| VII | 15·5 | 14·0 | 9·0 | 6·9 | 6·0 | 6·5 | 7·0 | — |
| VIII | — | 14·0 | — | 11·0 | 6·6 | 5·2 | — | — |
| IX | — | — | — | — | 6·6 | 7·0 | — | — |

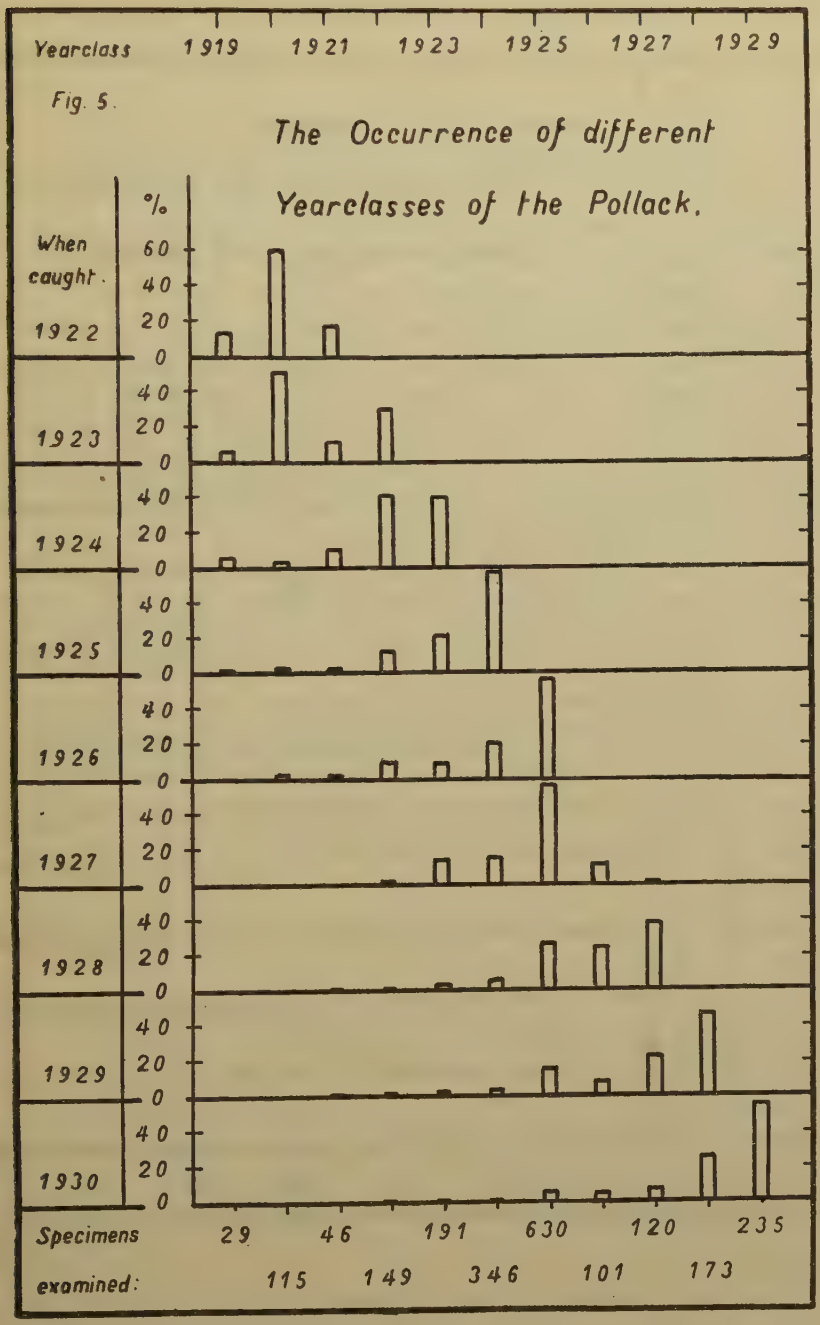
Tab. 3. *Year-group 1924. Søndeledfjord.*

| When caught: | $1_1$ | $1_2$ | $1_3$ | $1_4$ | $1_5$ |
|---|---|---|---|---|---|
| 1925—26 | 16·2 | — | — | — | — |
| 1926—27 | 15·2 | 31·0 | — | — | — |
| 1927—28 | 15·0 | 28·4 | 38·2 | — | — |
| 1928—29 | 14·5 | 29·2 | 39·2 | 48·8 | — |
| 1929—30 | 13·5 | 26·2 | 37·3 | 45·4 | 52·3 |

Tab. 4. *All Year-classes. Søndeledfjord.*

| Age of fish: | $1_1$ | $1_2$ | $1_3$ | $1_4$ | $1_5$ |
|---|---|---|---|---|---|
| 2 years | 17·1 | — | — | — | — |
| 3 „ | 16·6 | 31·2 | — | — | — |
| 4 „ | 16·0 | 30·0 | 40·2 | — | — |
| 5 „ | 15·1 | 29·1 | 38·8 | 47·6 | — |
| 6 „ | 13·5 | 26·2 | 37·3 | 45·4 | 52·3 |


Cm.
55
50
45
40
35
30
25
20
The average Length of the Pollack during the Calendaryear.
Fig 4
(11) Δ
Δ (4)
Δ (323)
Δ (1700)
○ Pollack caught in Traps. The Ciphers are smoothened by a movable Mean for three Month.
Δ Pollack caught at the Shore by a Seine about 1st of September.
The Number examined in (-).
I V IX I V IX I V IX I V IX
2nd. 3rd. 4th 5th. Year


Yearclass 1919 1921 1923 1925 1927 1929
Fig. 5.
The Occurrence of different Yearclasses of the Pollack.
When caught.
%
1922
1923
1924
1925
1926
1927
1928
1929
1930
60
40
20
0
Specimens examined:
29 46 191 630 120 235
115 149 346 101 173

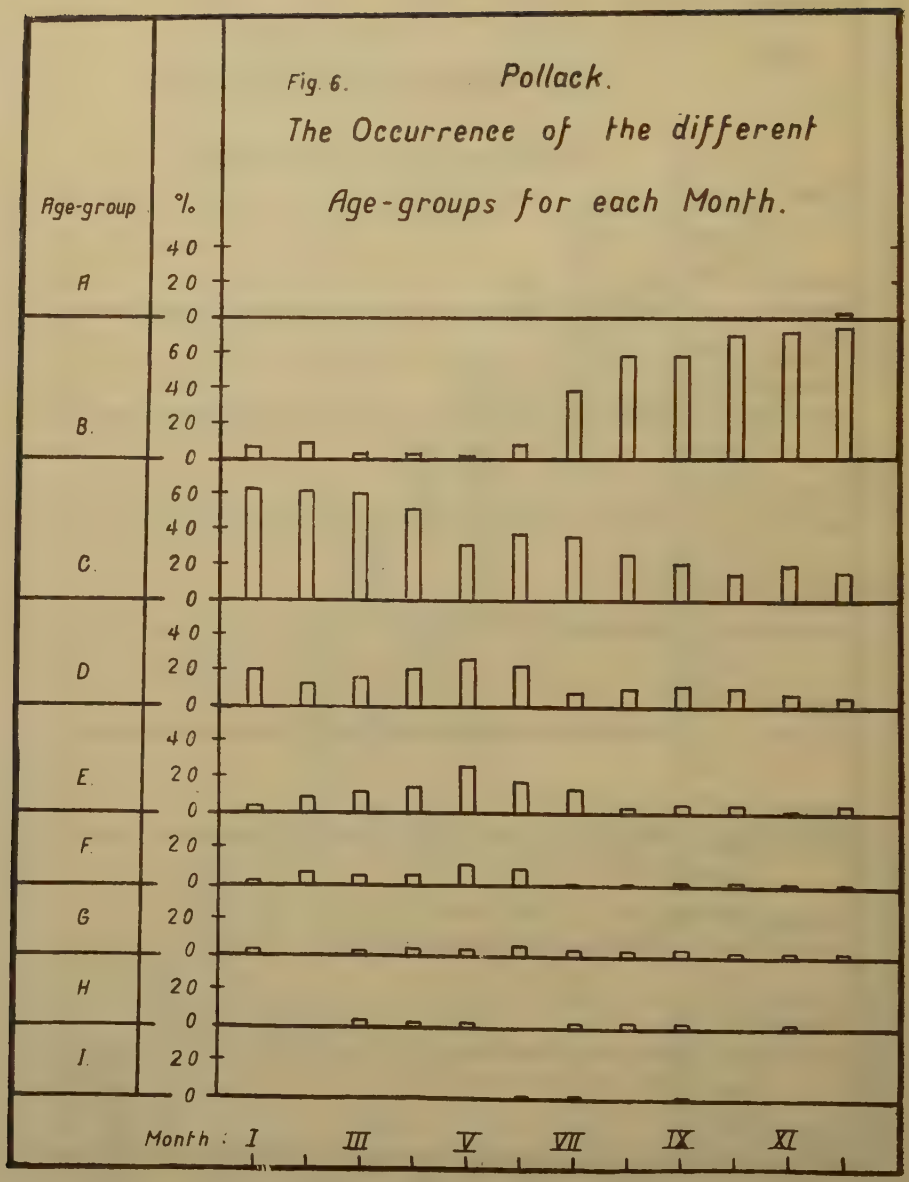


Fig. 6. Pollack.
The Occurrence of the different
Age-groups for each Month.
Age-group
%
A
B.
C.
D
E.
F.
G
H
I.
40
20
0
60
40
20
0
60
40
20
0
40
20
0
40
20
0
20
0
20
0
20
0
Month : I III V VII IX XI

The length of the pollack found by direct measurements of the fish from each season and of different ages is given in fig. 4. It will be seen that the curve is undulating, which means that the intensity of growth varies. The less intense growth occurs near the middle of Winter.

Each Autumn (August—September) about 100 hauls are made with a seine in the littoral region of our Skagerrack coast. The pollack caught here is distinctly smaller than the fish of the same age caught in traps at the same season — as will be seen from the same figure.

As to the size of the pollack in different waters, the variations are too small to be dealt with in this booklet, the material being too scanty.

Table 5 and fig. 5 give the total results as to the occurrence of different year-groups. The 1925 year-group is especially rich.

The total number of fish examined in each month is given in table 6. From the total it is evident that the pollack occurs in the traps especially in the late Summer and Autumn. By studying the table, however, it will be seen that the high number in that season is chiefly due to the very young fish. The older fish are best represented in Spring and early Summer. During the actual Winter the catches are low. The relative catches of the different age groups are given in fig. 6.

The right-hand column of tab. 6 shows that the pollack is caught in the traps at a very early age, about 46 % being fish in their second year, and about 29 % in their third.

The catches in the traps are not representative, however, the relatively large pollack being chiefly caught by hook and line, or in nets.

Tab. 5. *The occurrence of different year-groups.*

| | Year-group | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1919 | 1920 | 1921 | 1922 | 1923 | 1924 | 1925 | 1926 | 1927 | 1928 | 1929 | |
| When caught: | | | | | | | | | | | | |
| 1922 | 15 | 67 | 20 | — | — | — | — | — | — | — | — | 102 |
| [1] % | 13·5 | 60·4 | 18·0 | — | — | — | — | — | — | — | — | |
| 1923 | 2 | 17 | 4 | 10 | — | — | — | — | — | — | — | 33 |
| % | 6·1 | 51·5 | 12·2 | 30·3 | — | — | — | — | — | — | — | |
| 1924 | 3 | 2 | 6 | 24 | 23 | — | — | — | — | — | — | 58 |
| % | 5·2 | 3·5 | 10·7 | 41·4 | 39·6 | — | — | — | — | — | — | |
| 1925 | 2 | 8 | 7 | 32 | 54 | 145 | 1 | — | — | — | — | 249 |
| [2] % | 0·8 | 3·2 | 2·8 | 12·8 | 21·6 | 58·0 | 0·4 | — | — | — | — | |
| 1926 | 7 | 21 | 6 | 71 | 68 | 141 | 392 | — | — | — | — | 706 |
| % | 1·0 | 3·0 | 0·9 | 10·5 | 9·6 | 20·0 | 55·5 | — | — | — | — | |
| 1927 | — | — | — | 7 | 35 | 39 | 146 | 30 | 1 | — | — | 258 |
| % | — | — | — | 2·7 | 13·6 | 15·1 | 56·6 | 11·6 | 0·4 | — | — | |
| 1928 | — | — | 1 | 2 | 6 | 10 | 43 | 40 | 62 | — | — | 164 |
| % | — | — | 0·6 | 1·2 | 3·7 | 6·1 | 26·2 | 24·5 | 37·9 | — | — | |
| 1929 | — | — | 2 | 2 | 4 | 4 | 22 | 11 | 31 | 67 | — | 143 |
| % | — | — | 1·4 | 1·4 | 2·8 | 2·8 | 15·4 | 7·7 | 21·7 | 46·8 | — | |
| 1930 | — | — | — | 1 | 1 | 7 | 26 | 20 | 26 | 106 | 235 | 422 |
| % | — | — | — | 0·2 | 0·2 | 1·7 | 6·2 | 4·7 | 6·2 | 25·1 | 55·6 | |
| Total | 29 | 115 | 46 | 149 | 191 | 346 | 630 | 101 | 120 | 173 | 235 | 2 135 |

[1]) 9 older specimens not included. [2]) 1 older specimen not included.

## Tab. 6. *Pollack caught in traps 1922—1930.*

The occurrence of different year-groups during the year. Group A means fish caught in the calendar year when hatched, group B in the next year, and so on.

| Group | Months | | | | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | No. | % |
| A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0·1 |
| B | 5 | 5 | 2 | 3 | 1 | 9 | 75 | 206 | 163 | 162 | 217 | 136 | 984 | 45·8 |
| C | 47 | 34 | 44 | 69 | 39 | 45 | 70 | 88 | 58 | 34 | 57 | 28 | 613 | 28·5 |
| D | 16 | 7 | 12 | 29 | 33 | 28 | 15 | 36 | 30 | 23 | 19 | 9 | 257 | 12·0 |
| E | 3 | 5 | 9 | 20 | 35 | 22 | 27 | 13 | 15 | 10 | 6 | 8 | 173 | 8·1 |
| F | 2 | 4 | 4 | 8 | 15 | 12 | 2 | 1 | 5 | 5 | 2 | 1 | 61 | 2·8 |
| G | 2 | 0 | 1 | 4 | 3 | 6 | 5 | 7 | 8 | 1 | 1 | 1 | 39 | 1·8 |
| H | 0 | 0 | 2 | 1 | 1 | 0 | 1 | 5 | 1 | 0 | 2 | 0 | 13 | 0·6 |
| I | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 0·1 |
| Total | 75 | 55 | 74 | 134 | 127 | 123 | 196 | 356 | 281 | 235 | 304 | 185 | 2145 | 99·8 |